

Chapter Six:

Embankment Construction

Introduction 203.01

The purpose of this chapter is to teach the technician how to properly inspect embankment construction. The knowledge acquired will enable the technician to implement the skills necessary to insure a good, solid, and lasting embankment which is absolutely necessary for a durable and safe highway. Different classifications of materials encountered, lift requirements, compaction methods, benching, density tests, earthwork calculations, and specifications relating to each particular area of embankment of construction will be discussed.

Rock Embankment Section 203.20 (a) 203.03 203.15

Rock excavation shall consist of rock which cannot be excavated without blasting. It shall also include all boulders or other detached stones each having a volume of $\frac{1}{2}$ cubic yard or more.

In a rock fill, the lifts are thick, and the voids between the rock chunks are large. These voids are filled with fines at the top and sides of the embankment, but inside the embankment many large voids remain. If these rock pieces remain intact, deformations are small within the embankment, because of the friction and interlocking between pieces. Lift requirements include:

Lift Requirements 203.09

- * No large stones shall be allowed to nest, but shall be distributed over the area to avoid pockets. Voids shall be filled with small stones.
- * The final two feet of the embankment just below the subgrade elevation shall be composed of suitable material placed in layers not exceeding eight inches loose measurement, and compacted to the required density.
- * Shale or shale-like materials will not be permitted in the upper two feet of embankment.
- * Where the depth of an embankment is five feet and is to consist entirely of rock, the rock shall be deposited in lifts not to exceed the top size of the material being placed, but in no event exceeding four feet.

- * Where the depth of an embankment is five feet or less, or where the material being placed does not consist entirely of rock, the material shall be placed in lifts not to exceed the top size of the rock being placed, but in no event exceeding two feet.
- * The rock for any particular lift shall be deposited on and pushed over the end of the lift being constructed. If the voids of the last lift are not closed sufficiently, they shall be choked with small broken stones or other suitable material and compacted as directed.
- * Where a rock fill is to be placed over a structure, the structure shall first be covered with two to four feet of earth or other approved material, and properly compacted before the rock is placed.
- * Shale shall not be incorporated as rock embankment unless written permission is obtained.

Compaction
Methods
203.20

When rock is used for embankment construction and has such a large top size as to make it impractical to perform density tests, such material may be compacted with crawler-tread equipment or with approved vibratory equipment, or both. Each lift shall be compacted thoroughly by successive passes back and forth with the tread areas overlapping enough on each trip so that all portions will be compacted uniformly.

Shale And Soft
Rock
Embankments
Section
203.20 (b)

What would happen if a rock fill were built of rocks which weathered rapidly in the fill? The rock pieces would become soil, which could in turn fall down into the voids. The cumulative result of this would be, at least, considerable settlement of the embankment, and it could lead to slope failure. Shales are a good example of this, since large pieces may degrade (slake) into soil. This soil may in turn squeeze down into the large voids. The net result is that large settlements, and even slope instability, may occur. The following requirements are intended to reduce this settlement:

Lift And
Compaction
Requirements

- * Shale, shale and soft rock mixtures, or soft rock shall be placed in 8" maximum loose lifts.
- * The compaction shall be accomplished with an approved vibratory tamping-foot roller in conjunction with a static tamping-foot roller. Each tamping foot on the static roller shall project from the drum a minimum of 6". Each tamping foot on the vibratory roller shall project from the drum a minimum of 4".

- * Shale, shale and soft rock mixtures, or soft rock shall be compacted to at least 95 percent of maximum dry density.
- * The moisture content shall be controlled within -2 and +1 percentage points of optimum moisture content.
- * The density will be measured with a calibrated nuclear gauge.
- * Water shall be applied to the shale in the cut to accelerate the slaking action and again prior to disking and compaction.
- * The water shall be uniformly incorporated throughout the entire lift by a multiple gang disk with a minimum disk wheel diameter of 24 inches.
- * Unless otherwise approved in writing, each embankment lift shall receive a minimum of three passes with the vibratory roller.
- * The material shall be bladed before using the vibratory roller.
- * A roller pass is defined as being one complete coverage of a given area.
- * Water required to facilitate the slaking and compaction of the shale or soft rock will be paid for on a volume basis.
- * Several counties have relatively thin layers of shale and rock. Special provision restrictions will be required before this material can be used in embankments.

Embankments On Hillsides And Slopes Section 203.21

Benching

- * Before an embankment is placed on natural soil slopes or existing fill slopes steeper than 4:1, benches a minimum of 10 feet wide, unless otherwise specified, will be cut into the slopes prior to the placement of embankment fill.
- * Before placing embankment on natural soil slopes of 4:1 or flatter, the existing ground surfaces shall be plowed or deeply scarified.

Payment

- * If benches are cut, the excavation involved will be paid for at the contract unit price per cubic yard for the class or classes of excavation encountered.
- * No direct payment will be made for plowing or scarifying.

Embankment Over Existing Roads Section 203.22

Whenever constructing an embankment over an existing roadway, certain precautions must be taken:

Treatment Of Existing Pavements

- * If embankments for new pavement are to be placed over an area where a rigid pavement or any pavement having a concrete base is in place, the upper surface of which is 12 inches or less below the subgrade elevation of the proposed new pavement, the existing pavement shall be removed.

- * If embankment for new pavement is to be placed over an area where an existing rigid pavement is in place, the upper surface of which is more than 12 inches but less than 3 feet below the subgrade elevation of the proposed new pavement, the existing pavement shall be broken. Pavement shall be broken so the area of any individual slab does not exceed one square yard.
- * If embankment for new pavement is to be placed over an area where a bituminous-type surface on a concrete base is in place, and such existing surface is more than 12 inches but less than 3 feet below the subgrade elevation of the proposed new pavement, the bituminous courses shall be removed and the concrete base is broken.
- * If embankment for new pavement is to be placed over an area where a flexible-type pavement is in place, the top of which is set at the approximate elevation of 12 inches or less above or below the required subgrade elevation of the proposed new pavement, the existing pavement shall be broken and removed to the depth directed, but no less than 12 inches.
- * If embankment for new pavement is to be placed over any existing pavement, the top of which is greater than 3 feet below the required subgrade elevation, the existing pavement will be left in place.
- * If an embankment is to be widened, due precautions shall be taken to ensure a firm foundation. After all perishable material has been removed, the existing shoulders shall be plowed down 2 feet out from the existing pavement. This material shall be used for widening. Benches, a minimum of 4 feet wide, shall be cut into slopes of the old embankment unless otherwise directed. No direct payment will be made for plowing or benching, the cost thereof to be included in the various pay items of the contract.

Density Control
(Compaction)
Section 203.23

The following density control requirements are included in the duties of the grade technician:

- * Unless otherwise specified, all embankments shall be compacted to at least 95% of their maximum dry density.
- * The moisture content shall be controlled within -2 and +1 percentage points of optimum moisture content.
- * If the embankment material is too wet, the material shall be aerated to remove excess moisture.

- * If the embankment material is too dry, it shall be watered and disked to increase the moisture content.
- * The embankment material shall be placed in uniform level layers, and compacted with approved compacting equipment. Compacting equipment shall include at least on 3-wheel roller or other compacting equipment capable of providing a smooth and even surface.
- * Each lift shall be disked or treated by some other mechanical means which shall ensure the breaking up of any existing lumps and clods.
- * The loose depth of each lift shall be such that the required compaction can be obtained, but in no case shall it exceed 8".
- * Where a tamping roller is used, the loose depth of lift shall not exceed the length of the tamper feet. The surface area of the end of each foot of the tamping roller shall be no less than 5 square inches.
- * When silts, silty loams, or loessial type soils are encountered and used in embankment construction, the moisture content shall be controlled within -3 percent of optimum and the optimum moisture content.
- * Field compaction tests shall be run on each lift, and the required compaction obtained on each lift before the next lift is placed.
- * The moisture content for sand soil or a sand and gravel soil, having at least 80% sand and gravel size particles, shall be such that the soils may be compacted to the specified density, which is normally several percentage points below optimum or as directed.

Settlement
Control
204.03

Preliminary investigation has found that the existing soil below the embankment will settle over time when a heavy embankment is constructed. Therefore, settlement control is necessary to measure this settlement and to insure that the settlement has slowed to an acceptable rate.

- * This work shall consist of providing, installing, maintaining, and reading various types of geotechnical instrumentation at locations shown on the plans or as directed.
- * Prior to the beginning of embankment operations in any area, ½ inch by 3 feet by 3 feet settlement plates equipped with sections of 2" pipe shall be installed at locations as shown in the plans.

- * The 2" pipe sections for the settlement plates shall be 4 feet. Such pipe sections can be extended vertically from the

center of the plates up through the new embankment as it increases in height. The pipe sections shall be spot welded at the joints. The 2" steel pipes shall extend 2 feet or more above the grade of the new embankment at all times during grading operations and settlement period.

- * In addition to the settlement plates as specified, toe stakes shall be installed at the toe of slope opposite each settlement plate. The toe stakes will be $\frac{3}{4}$ inch by 4 foot steel rods.
- * B Borrow will be used as embankment material around settlement plates and pipe in order to protect them during construction.
- * After the embankment has been constructed to subgrade elevation, shoulder stakes will be installed at the locations as set out in the plans. The shoulder stakes will be $\frac{3}{4}$ inch by 4 foot steel rods.
- * During the construction of the embankment, elevation readings will be taken on all settlement plate extension pipes and toe stakes at the end of each 7-day period, or more frequently if the conditions warrant.
- * After the embankment has been constructed to subgrade elevation, readings will be taken on the shoulder stakes, in addition to the settlement plate extension pipes and toe stakes as set out.
- * Unless otherwise directed, the new embankment, after being constructed to subgrade elevation, will be allowed to settle for a period of three months.
- * In the event that the results of the instrument readings indicate that the new embankment is still in a state of settlement at the end of the third month by more than 0.01 foot per 7-day period for any of the final four consecutive weeks, then such embankments shall be allowed additional settlement time until instrument readings indicate that the settlement is 0.01 foot or less per 7-day period for four consecutive weeks.
- * In the event that serious settlement develops during the construction of the embankment or within the required settlement period, the work will be suspended and corrective measures taken as directed.

Method of
Measurement
203.27

Pay Item	
Borrow.....	cys
Breaking Pavement.....	sys
Cased Test Holes.....	lft
Embankment.....	cys
Emb. Foundation Soils Treatment.....	sys
Excavation, Common.....	cys
Excavation, Peat.....	cys
Excavation, Rock.....	cys
Excavation, Unclassified.....	cys
Excavation, Waterway.....	cys
Excavation, Y.....	cys
Exploratory Cores.....	lft
Exploratory Drilling.....	lft
Linear Grading.....	sta
Water for Shale.....	gal